

Distribution of *Bemisia* Parasitoids in Central California

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Large scale releases of *Eretmocerus emiratus* (M95104, U.A.E.), *Eretmocerus* nr. *emiratus* (M96076, Ethiopia), *E. mundus* (M92014, Spain), *E. hayti* (M95012, Pakistan), and fewer numbers of *Encarsia sophia* (= *transvena*; M95107, Pakistan) were made into four citrus orchards from 1997 through 2000. Three study sites were identified initially, one each in Fresno, Kern, and Tulare Counties. A fourth was added because one of the original growers changed farming practices. Sites consisted of adjacent citrus and cotton acreage managed by the same owner with a history of silverleaf whitefly (SLWF) problems. Parasite releases begin in early August or September 1997, 1998, 1999, and 2000 when migrating whitefly nymphs were first recorded from citrus leaves. Typically, over 100,000 parasites were released weekly at each location with 4.05 million released in 1997, over 10 million in 1998, 3.2 million in 1999, and 124,000 (*E. sophia*) in 2000.

Parasitism of SLWF on citrus was generally low during years of releases, averaging 28 percent overall. However this value is quite high with respect to an earlier survey, in which less than 1.5 percent of nymphs examined on cotton and other weedy plants from the same region were found parasitized. During years in which exotics were being released, most of the parasitoids recovered from weed samples taken within one mile of citrus orchards were exotic, 81 percent to 95 percent. Two years after the last releases of exotic *Eretmocerus* spp., (fall 2001), the proportion of all parasitoids that were exotic dropped to 11 percent on weed samples. Although primarily *E. emiratus* (M95104 + M96076) was released, *E. mundus* (M92014) was the dominant species recovered in fall 2001. The density of SLWF on weeds has varied about the same from 1998 to 2001, most samples from 0.1 to less than 20 per gram dry weight.

Additional monitoring of the parasite population was conducted in 2002 to determine the presence and distribution of released parasitoids. The San Joaquin Valley is very large, over 300 miles long. Many years will be needed before the parasitoids have spread to their ultimate range. Not until they have spread out across the Valley will their full impact be realized. Additionally, continual monitoring will be needed to determine exactly what whiteflies are attacked by the released parasitoids due to concerns regarding non-target impacts.

Materials and Methods: Two sampling protocols were conducted in late summer to early fall. The first utilizes an existing sampling program managed by the Pink Bollworm (PBW) Program, California Department of Food and Agriculture (CDFA). Twice monthly from July through September, close to five percent of PBW trap sites in the San Joaquin Valley were sampled. There were 89 sites in Kern County, 72 in Kings, 57 in Tulare, 125 in Fresno, 29 in Merced and 13 in Madera. Ten leaves from 10 separate plants were selected from each site. Leaves are taken from the fifth mainstem node below the terminal. Leaves from each site are placed in a separate container labeled with the county, site, number, and date of collection. Plants are within 10 meters of a PBW trap. Leaves with high numbers of whiteflies (50 or more per leaf) were retained in one-pint paper cans, and shipped to the CDFA's Biological Control Program in Sacramento. Paper cans were held at room temperature for at least five weeks. The numbers of emerged parasitoids, native and exotic, as well as whiteflies were recorded.

The second sampling effort focused on identification of host whiteflies. Parasitoids are reared from isolated whitefly hosts to insure identification of host species. Once during August or September, six cotton fields were sampled for SLWF infested cotton leaves in the southern San Joaquin Valley. Four of these fields were near each of the four original release sites, and

two were distant. Since most cotton fields are sprayed with insecticides, weedy plants were sampled from an additional two locations within two miles of release sites. Leaves were shipped to Sacramento and processed for the presence of exotic parasites. Up to 40 nymphs from each sample location that appeared parasitized were carefully removed from leaves. Nymphs were placed into plastic emergence trays (Pro-Bind™ assay plate, 96, 0.3 ml wells, u-bottom, by Falcon®), one per well and incubated at room temperature. An absorbent paper cloth was placed between the top and bottom of the tray to prevent emerging insects from moving into adjacent wells. Trays and a dish of salt slurry were placed in a plastic food container to maximize humidity. Recovered parasitoids and host exuviae were identified to species or genus. Mr. Ray Gill, CDFA identified whitefly exuviae.

Results: Collections of leaves came from Fresno, Kern, Kings, Merced, and Tulare Counties. Most came from the latter three. Cotton leaf samples were retained by the PBW Program from 30 sample sites, placed into paper one-pint containers and shipped to Sacramento. For the more detailed survey, whitefly nymphs were recovered from cotton, nightshade (*Solanum* sp.), spurge (*Euphorbia* sp.), holy hock, purple potato vine, squash (Curcubitaceae), and sunflower (*Helianthus*), and bean (Table 1).

Table 1. Parasitoids, Host Whitefly and Plants, 2002

Species	Sex	Host plant	Host whitefly
<i>Eret. native</i>	♀	Cotton	<i>Bemisia tabaci</i>
<i>Eret. native</i>	♀	Purple potato vine	<i>B. tabaci</i>
<i>Eret. native</i>	♀	Purple potato vine	<i>Trialeurodes abutilonea</i>
<i>Eret. native</i>	♀	Sunflower	<i>B. tabaci</i>
<i>Eret. native</i>	♀	Holly hock	<i>B. tabaci</i>
<i>Eret. native</i>	♀	Egg plant	<i>B. tabaci</i>
<i>Eret. native</i>	♀	squash	<i>B. tabaci</i>
<i>Eret. native</i>	♀	Mulberry	<i>Tetraleurodes mori</i>
<i>Eret. mundus</i>	♀	Cotton	<i>B. tabaci</i>
<i>Eret. mundus</i>	♀	Purple potato vine	<i>Trialeurodes abutilonea</i>
<i>En. meritoria</i>	♀	Cotton	<i>B. tabaci</i>
<i>En. meritoria</i>	♀	Holly hock	<i>Trialeurodes abutilonea</i>
<i>En. coquillett</i>	♀	Cotton	<i>B. tabaci</i>
<i>Eret. native</i>	♂	Cotton	<i>B. tabaci</i>
<i>Eret. native</i>	♂	Purple potato vine	<i>Trialeurodes abutilonea</i>
<i>Eret. native</i>	♂	Mulberry	<i>Tetraleurodes mori</i>
<i>En. pergandiella</i>	♂	Cotton	<i>B. tabaci</i>
<i>Eret. exotic</i>	♂	Cotton	<i>B. tabaci</i>
<i>Eret. exotic</i>	♂	Nightshade	<i>B. tabaci</i> ¹
<i>Eret. exotic</i>	♂	Sonchus	<i>B. tabaci</i> ¹
<i>Eret. exotic</i>	♂	spurge	<i>B. tabaci</i> ¹
<i>Eret. exotic</i>	♂	Bean	<i>B. tabaci</i>

¹Host not identified by Mr. Gill

The only exotic parasitoid recovered with certainty was *E. mundus*. Three other species, *E. emiratus*, *E. hayati*, and *E. sophia* were released from 1995 to 2000. *E. mundus* was recovered primarily from *Bemisia tabaci* infesting cotton. However, it may also attack *B. tabaci* on the weeds collected in this survey, from which exotic, male *Eretmocerus* were recovered. Unfortunately, they cannot be identified to species. One record came from banded wing whitefly, *Trialeurodes abutilonea* infesting purple potato vine.

Recovery of parasitoids from the PBW survey came entirely from cotton leaves infested with *B. tabaci*. All the recovered parasitoids were species of *Eretmocerus*. The percentage of male *Eretmocerus* that were exotic varied from zero to 47 percent, with one exception of 100 percent;

however only one parasitoid was recovered in that sample. In eight of 30 samples taken from Fresno, Kern, Merced, and Tulare Counties, we recovered exotic, male parasitoids.

Combining data from both surveys, the map in (Figure 1) shows the distribution of recoveries and relative magnitude of parasitoids and whiteflies. The greatest concentration of exotic parasitoids is at the southern region of Kern County. Note: the large stars represent the original release sites in citrus groves where more than one million parasitoids were released. The minor release sites were non-crop annual plants or cotton into which less than 50 thousand parasitoids were released (see Biological Control Reports for 1998, 1999). Most of the recovered parasitoids near the original release site were exotic. These parasitoids have spread at least 10 miles. A larger percentage of *Eretmocerus* were native at our original release site in Fresno and Tulare Counties. No parasitoids were recovered from four sites in western Fresno County, while some natives were found at two sites north of these (Figure 1).

Figure 1. Distribution of Recovered Parasitoids and Whiteflies from the Pink Bollworm and Host Survey Data

